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The production of scallop seed

by

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Foreword

During the last few years, our center made rapid progress ~~with regard to~~ with natural scallop seed collection in the Mutsu Bay, and we were able to obtain very large quantities of spats. However, we were not quite successful in eliminating the yearly variations in the volume of collected natural seed and the supply of seed remains ~~necessarily~~ insecure. So, from 1963 on our center started to study the artificial collection of scallop seed. In 1968 we started the production of seed.

Our new center provided with artificial collection facilities had just been completed. This year which is the second of our operations we were able to collect about 210,000 spats with an average shell length of 1.3 mm (mid-July 1969) as a result of seed production aimed at collecting large quantities of seed. We learned a few things and encountered some problems while seeking a large seed production. The findings are reported here. However, we first want to thank the personnel of the Fishermen's Cooperative of Kawauchi, Shimokita Township for their cooperation in the gathering of scallop (adult) ~~mother shells~~.

Materials and methods

1) ~~Mother shells~~ Adv Hs

Table 1 shows the ~~mother shells~~ adults used for spawning ~~induction~~, spawning control and for the ~~survey~~ determination of gonad maturity.

2) Artificial Spawning ~~induction~~

We placed 8 ~ 12 ~~mother shells~~ adults in fish boxes through which we ran 5 ~ 6°C seawater. Thereafter we changed to warm seawater and induced spawning by raising slowly the temperature so that the water temperature inside the fish boxes would reach 14 ~ 15°C within 1.0 ~ 1.5 hours.

3) Delayed Spawning ~~control~~

We placed about 70 ~~mother shells~~ adults in a 1 t concrete tank through which we ran filtered seawater cooled to 5 ~ 6°C. This was carried out from January 29 to April 18.

4) Rearing of free-swimming larvae p. 276

Table 2 shows the rearing method. When the free-swimming larvae reach the attachment stage (determined by the shell length and the appearance of ocelli), we suspended in the tank fibrous skins of hemp palms, Hizex* films, onion bags, daiō** nets, netoron** nets ~~serving~~ did served as collectors.

Translator's notes: * attempted rendering; transliterated as haizekkusu; meaning uncertain; probably some synthetic material.

** as transliterated; meaning uncertain; probably a synthetic fiber.

5) Rearing of the spat at the early attachment period

The method was practically the same as for the free-swimming larvae. Every 3 days, 1/2 of the water was changed. We fed the spat 10,000 ~ 12,000 cells (in Mc numbers) per individual per day.

6) Rearing of the spat after transfer to sea

When the attached spat reached about 1 mm in length they were placed successively in large size onion bags or in gauze (synthetic fiber fabric with 200 μ mesh) bags and reared suspended from a line. The transfers to sea took place seven times from April 14 to May 15.

By the time of the intermediate rearing, we examined the shell length and the yield 3 times according to the times of transfer to sea.

Results

1) Spawning induction and state of maturity

The results are shown in Table 3. Fig. 1 shows the seasonal variations of the $\frac{\text{gonad weight}}{\text{soft parts weight}} \times 100\%$ of the mother shells produced in Kawauchi.

From mid-to-late March the spawning or spermatizing responses to temperature stimulation were rapid. On March 28 we noted natural spawning among mother shells under a stream of normal temperature seawater (6.5°C ~ 7.5°C) in the collection room.

From the beginning of March, the rate of spawning induction rose gradually to reach a peak in late March and the gonads grew suddenly heavier from the beginning of March. These facts seem to indicate that

if ~~the~~ environment conditions are appropriate in late March there is an immediate spawning possibility.

So, from around early March, it becomes possible to carry out egg collections among ~~mother shells~~ adults in the natural environment at Kawauchi. We know that late March is the best time but were unable to discover how long such conditions prevail.

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2) Spawning ~~control~~ delayed

With regard to spawning ~~control~~ delayed, we were unable to achieve our original goal. We started too early, too many ~~mother shells~~ adults were placed in too little water and no feeding was carried out. So, the color of the gonads was pale and they looked atrophied.

3) Rearing of the free-swimming larvae p. 278

In all cases, the ascent of the larvae was most active about 20 hours following fertilization. After about 50 hours, most larvae had reached the early D-type stage.

Table 4 shows the rearing results in the various tanks.

As the temperature of the rearing water, the density of ~~the~~ ~~reared~~ larvae, ~~the~~ amount of ~~feed~~ good per larva, the types of ~~feed~~ food and the quality of rearing water were not different from last year, we were unable to perform comparative tests. We should rationalize the operations by improving the rearing tanks and adopting high-density rearing methods so as to achieve mass rearing. p. 279

4) The collectors

They were tentatively placed vertically or horizontally in the rearing tanks. When the collector was vertical, we noted an excessive

attachment density from the surface of the water to a depth of about 15 cm. Attachments grew sparser at the lower levels. With horizontal collectors, there seemed to be an excessive attachment density at the level of the collector close to the water surface.

Table 5 shows the state of attachment and the various handling problems by type of material used as collector.

5) Rearing of spats at the early attachment stage

We discovered that spats at the early attachment stage grow several times faster than free-swimming larvae. This means that till the time of transfer to sea, the spats grow by 35 μ - 45 μ per day and their 0.8 mm shell reached a length of about 1.5 mm.

On the other hand, when the collector is shaken, a large number of shells were seen to fall off. We are not quite sure about the cause but the phenomenon seems to be due to a lack of feed or to a deterioration of water quality (water change periods, volume of water changed).

We also have to ascertain the appropriate time for transfer to sea.

6) Rearing after transfer to sea

Table 6 shows the results of rearing following transfer to sea.

At the moment of transfer to intermediate culture (July 15 ~ 18), we noted almost no differences in growth due to lags in the time of transfer to sea. To the contrary, the individuals transferred to sea during the second half of the period exhibited a smoother growth and were on the whole larger.

In order to prevent the attached spats from falling off the collectors at the moment of transfer to sea, we lowered these collectors in the sea after placing them in bags made of gauze. However, drifting mud clogged the 200 µg mesh and this seemed to hinder the passage of water and to inhibit growth . So, we removed the gauze.

In the meantime, the yield immediately prior to shifting to intermediate culture with the 1st transfer to sea was excellent. The counted volume of survivals just before attachment was 10%. Thereafter, the values for the other transfers to sea ranged from 3.9% to 4.0% so that the total average did not exceed 5.8%.

As for the causes for natural decrease following transfer to sea, we noted preying by surf fish, crabs, umisemi*. This year there was almost no preying by starfish. From the beginning of July, spats fallen from the collectors gathered at the bottom of the bags. Some locked together. At the time preceding immediately intermediate culture, about 9% of the whole had died.

We finally compared the growth of seed and spats gathered under natural conditions in the Mutsu Bay in early July to that of artificially obtained seed and spats. The results can be seen in Table . 7 It shows that better growth was achieved with artificially obtained seed than with seed collected under natural conditions.

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* Translator's note: as transliterated; meaning uncertain; literally: "sea cicada".

Table 1 ~~Mother shells~~ Adults employed

Site of collection	Time of collection	Number of collections	Number of inductions	Total number of ~~mother shells~~ adults	Age
Kawauchi	Dec. 21, 1968-March 28, 1969	8	8	about 600	3-6 years
Ominato	Feb. 25, 1969-Feb. 27, 1969	2	1	" 300	3-5 years
Urada	Feb. 13, 1969-March 10, 1969	2	2	" 40	"
Moura	Dec. 24, 1968-Jan. 29, 1969	2	2	" 200	2-4 years

Table 3 Spawning induction and state of maturity

誘発番号 a	採捕漁場 b	採捕月日 c	誘発月日 d	誘発率 (%) e		生殖巣重量/軟体部重量 ×100 f の当時の平均		備考 g	
				♀	♂	♀	♂		
1	川内	h 29/1	14/2	0	0	22.1	21.1	30/1 より役へ垂下	l
2	大湊	i 25/2	25/2	0	0	27.3	29.2	運送時凍死	m
3	大湊	i 27/2	27/2	4.0	31.0	27.3	31.6		
4	川内	h 4/3	4/3	5.0	60.0	26.4	28.1		
5	川内	h 10/3	10/3	30.7	17.6	26.3	30.9		
6	川内	h 14/3	14/3	51.9	23.8	27.3	26.8		
7	川内	h 18/3	18/3	33.1	11.1	29.1	27.4		
8	川内	h 22/3	22/3	75.0	14.3	23.1	29.3		
9	川内	h 28/3	28/3	72.2	84.6	27.6	27.1		
10	川内	h 29/1 2月～3月	j 18/4	0	0	24.7	28.9	29/1 (産卵抑制員)	n
11	川内	h 2～3月	k 1/5	0	0	25.8	27.9	2～3月 (各誘発の残りの母貝)	o

a Induction No.
b Collection site
c Collection date
d Induction date
e Induction rate (%)
f Average $\frac{\text{gonad weight}}{\text{soft parts weight}} \times 100$ (%) at the time
g Remarks
h Kawauchi
i Ominato
j Jan. 29, Feb.-March
k Feb.-March
l Suspended to raft from Jan. 30
m Died from frost during shipping
n Jan. 29 (shells used for spawning control)
o Feb.-March (mother shells remaining after the various inductions)

Table 2 Methods of rearing the free-swimming larvae

Rearing tank	0.65 t soft polyethylene tank (capacity: 500 L)
Rearing density	560-1,560 individuals/L
Aeration	continuous gentle passage of air
Water change	entire water changed every 3 - 5 days; removing the rearing seawater with a siphon and according to growth, a 50 μ - 150 μ mesh screen is passed through; the larvae remaining on the screen are transferred to a tank containing new seawater.
Rearing temperature	15 ± 1°C
Feed	Monochlysis lutheri Chaetoceros calcitrans
Amount fed	Mixed feed (in cell numbers, at the ratio of Mc: Ch = 1:2) was given twice (morning, evening) daily. From the start to the 5-7th day of rearing (average shell length: 147 μ) we gave (in Mc conversion figures) 2,000 cells per larva per day; thereafter until the 9-11th day (average shell length of 190 μ) we gave 4,000 cells per larva per day); after that we gave 6,000 cells per larva per day.

Table 4 Rearing of the free-swimming larvae

第4表 浮遊幼生飼育状況

a 誘発番号	b 水槽番号	c 誘発月日	d 受精月日	e 幼生個体／水槽および幼生個体／ℓ	f 稚出現までの日数	g 稚出現までの生存率	h 付着までの日数	i 付着までの生存率と個体数
3	1	27/2	28/2	46万個 960個	10日	7.3%	16日	2.1% 1.0万個 j
4	1	4/3	5/3	32 640	9	75.0	20	31.0 10.0
	2	4/3	5/3	28 560	9	79.0	20	29.0 8.0
5	1	10/3	10/3	40 800	10	89.0	19	79.0 31.5
	2	10/3	10/3	40 800	10	65.0	19	64.0 25.5
6	1	14/3	14/3	52 1,040	10	77.0	18	34.0 17.5
	2	14/3	14/3	52 1,040	10	70.0	18	52.0 27.0
	3	14/3	14/3	50 1,000	10	80.0	—	水槽パンク全滅 k
	4	14/3	14/3	50 1,000	10	54.0	18	41.0 20.5
	5	14/3	14/3	51 1,020	10	51.0	18	34.0 17.5
	6	14/3	14/3	48 980	10	60.0	18	57.0 27.5
	7	14/3	14/3	48 980	10	53.0	18	48.0 23.0
	8	14/3	14/3	54 1,080	10	55.0	18	44.0 24.0
	1	18/3	18/3	52 1,040	9	42.0	16	27.0 14.0
	2	18/3	18/3	54 1,080	9	38.0	16	6.0 3.5
	3	18/3	18/3	64 1,280	9	14.0	16	1.0 0.64

a 誘発番号	b 水槽番号	c 誘発月日	d 受精月日	e 幼生個体／水槽 および 幼生個体／ℓ	f 殻頂形出までの日数	g 殻頂期までの生存率	h 付着までの日数	i 付着までの生存率と個体数
7	4	18/3	18/3	57万個 l j 1,140個	−日	−%	−日	水槽バンク全滅 k
	5	18/3	18/3	57 1,140	9	43.0	16	2.0 %　j 1.0万個
	6	18/3	18/3	50 1,000	9	35.0	16	23.0 11.5
	7	18/3	18/3	46 920	9	76.0	16	2.0 1.0
	8	18/3	18/3	43 860	9	81.0	16	33.0 14.0
	9	18/3	18/3	78 1,560	9	35.0	16	10.0 8.0
	10	18/3	18/3	78 1,560	9	23.0	16	10.0 8.0
8	1	22/3	22/3	50 1,000	9	99.0	15	16.0 8.0
	2	22/3	22/3	50 1,000	9	95.0	15	38.0 19.0
	3	22/3	22/3	50 1,000	9	94.0	15	44.0 22.0
	4	22/3	22/3	50 1,000	9	70.0	15	45.0 22.5
	5	22/3	22/3	50 1,000	9	39.0	15	11.0 5.5
計				1,424万個	j			371.14万個 j
平均				50.9万個 l j 1,018個	9.4日	59.2%	16.9日	30.1 %　j 14.3万個

a Induction No.
b Tank No.
c Induction date
d Fertilization date
e Larvae/tank and larvae/L
f Number of days before umbo expansion
g Survival rate before umbo expansion
h Number of days before attachment
i Survival rate and number of individuals before attachment
j 10.000
k Loss of entire tank bank
l Individuals

(Note) Rearing temperature: 15°C (± 1) Volume of water: 500 L

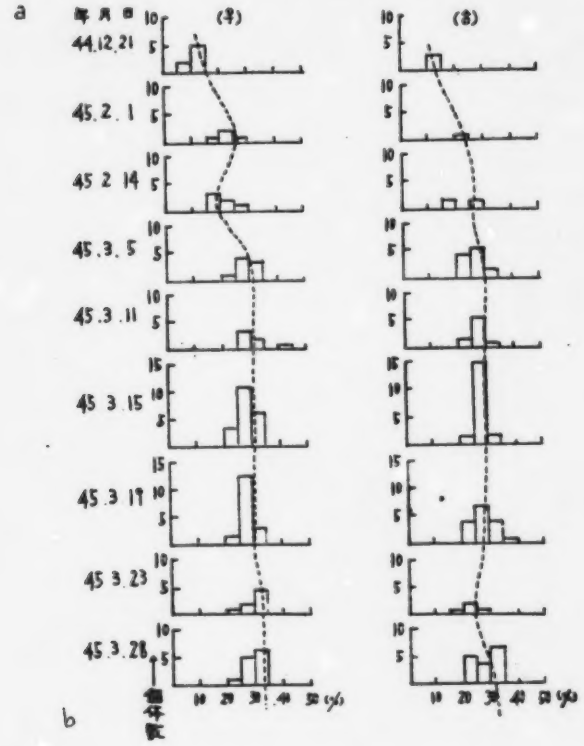

Fig. 1 seasonal variations of

$$\left(\frac{\text{gonad weight}}{\text{soft part weight}} \times 100\%\right)$$ (Kawauchi)

a Date b Number of individuals

Table 5 Characteristics of the materials used as collector

Material / Date	Fibrous skin of hemp palm	Hizex film	Onion bags	Daio nets	Netoron nets
fabrication	takes time	simple	very simple	simple	simple
attachment	very good	ordinary	ordinary	ordinary	ordinary
problems	dirt of rearing water gathers on collector; easy observation	easy observation, easy to handle, attachment uneven	observation difficult, easy handling	observation easy	observation difficult, easy to handle, good growth after transfer to sea
dispersion	takes time	easy	ordinary	ordinary	ordinary

Table 6 Growth after transfer to sea
(measurement based on 100 spats chosen at random among individuals collected)

仲出し順 a	誘発番号 b	附着直前 c の幼生数	d 6月1日測定 A(1)	d 6月1日測定 B	e 7月1日測定 A(2)	e 7月1日測定 B	f 7月15～18日測定 A(3)	f 7月15～18日測定 B	中間育成 数 g	C	D
1 (14/4)	3・4・5	76万	4.3 mm	3.3 mm 68.7 μ/h	9.6 mm	5.3 mm 176.7 μ/h	10.5 mm	0.9 mm 60.0 μ/h	76,100個 i	10.0%	9.0%
2 (16/4)	6	157万	4.0	3.0 65.2	8.8	4.8 160.0	9.3	0.5 31.3	33,600	4.4	12.0
3 (23/4)			3.5	2.5 64.1	8.4	4.9 163.3	10.1	1.7 106.3	13,600		10.0
4 (24/4)			3.9	2.9 76.3	9.1	5.2 173.3	10.9	1.8 112.5	22,000		7.0
5 (28/4)	7	61.1万	3.7	2.7 79.4	8.9	5.2 173.3	11.0	2.1 123.5	6,000	3.9	7.0
6 (8/5)			3.2	2.2 71.0	7.9	4.7 156.7	10.5	2.9 161.1	17,600		6.0
7 (9/5)	8・9	77万	2.6	1.6 94.1	7.1	4.5 150.0	10.0	2.9 161.1	37,000	4.8	10.0
計		371.1万 j							205,900		
平均 k			3.6	2.6 74.1	8.5	4.9 164.8	10.3	1.8 108.0		5.8	8.8

a Order of transfer to sea
b Induction No.
c Number of larvae just before attachment
d Measured June 1
e Measured July 1
f Measured July 15-18
g Numbers in intermediate culture
h Day
i Individual
j 10.000
k Average

(Note) A (1) shell length from transfer to sea to June 1
(2) " " from June 1 to July 1
(3) " " from July 1 to July 15-18

B Growth in (1) (2) (3) of A and elongation of shell per day

C $\frac{\text{number in intermediate culture}}{\text{number of larvae just before attachment}} \times 100\ (\%)$

D % of dead spats on July 15-18

Table 7 Comparison of shell length composition between seed and spats collected under natural conditions at the various sites of the Mutsu Bay and artificially collected seed and spats

a 項目 / i 組合名	設置月日 b	調査月日 c	附着器1個当りの平均重量 d	附着器1個当りの殻長毎の附着量（個） e				
				2㎜以下 f	2～5㎜	5～10㎜	10㎜以上 g	合計 h
j 蟹田町第一	4.10～25	7.1	1,075 g	37 (22.7)	88 (54.0)	38 (23.3)	0	163
k 奥内	4.24	7.1，4	1,000	87 (22.6)	268 (69.6)	30 (7.8)		385
l 茂浦	4.23	7.4	1,047	97 (34.2)	179 (63.0)	8 (2.8)		284
m 野辺地	4.24～5.2	7.2	1,040	320 (33.9)	543 (57.6)	80 (8.5)		943
n 横浜	4.26	7.2	1,431	370 (56.9)	174 (26.8)	106 (16.3)		650
o むつ市	5.5	7.2	1,227	813 (63.1)	383 (29.7)	93 (7.2)		1,289
p 川内	5.3～4	7.1	2,210	370 (43.5)	453 (53.3)	27 (3.2)		850
q センター人工採苗	－	7.1	－	－	4 (4.4)	73 (81.1)	13 (14.4)	90

a Datum
b Date established
c Date of survey
d Average weight per collector
e Number of attachments per shell length per attachment surface (individuals)
f Less than 2 mm
g Over 10 mm
h Total
i Name of cooperative
j Kanita-dai ichi
k Okunai
l Moura
m Nobeji
n Yokohama
o Mutsu City
p Kawauchi
q Center artificial collection